Scientific Inquiry

7-1 The student will demonstrate an understanding of technological design and scientific inquiry, including the process skills, mathematical thinking, controlled investigative design and analysis, and problem solving.

7-1.2 Generate questions that can be answered through scientific investigation.
Taxonomy Level: 6.1-B Create Conceptual Knowledge

Previous/Future knowledge: In 3rd grade (3-1.3), students generated questions such as "what if?" or "how?" about objects, organisms, and events in the environment and use those questions to conduct a simple scientific investigation. In 5th grade (5-1.1), students identified questions suitable for generating a hypothesis. In 8th grade (8-1.4), students will generate questions for further study on the basis of prior investigations.

It is essential for students to know that only testable questions (which are used to test one independent (manipulated) variable) can be answered through a scientific investigation and data collection. The question should include the relationship between the independent (manipulated) and dependent (responding) variable. For example, the following are examples of testable questions:

- How does the amount of exercise affect heart rate and breathing rate?
  - The independent (manipulated) variable is the amount of exercise (number of repetitions, amount of weights, duration of exercise).
  - The dependent (responding) variable, involving two body systems interacting, are heart rate and breathing rate.
- How does the amount of clay in soil affect permeability of water?
  - The independent (manipulated) variable is amount of clay in the soil.
  - The dependent (responding) variable is the rate of permeability of water.
- Does the amount of baking soda added to vinegar affect the amount of gas produced?
  - The independent (manipulated) variable is amount of baking soda.
  - The dependent (responding) variable is amount of gas produced.

It is also essential for students to know that a prediction about the relationship between variables is formed from the testable question. This prediction is called a *hypothesis*.

- All controlled investigations should have a hypothesis.
- A hypothesis can be stated positively or negatively. For example,
  - The longer the duration of exercise, the faster the heart and breathing rate. (positive statement)
  - The more clay in the soil, the lower the rate of permeability of water. (negative statement)
  - The more baking soda added to the vinegar, the greater the amount of gas produced in the reaction. (positive statement)
- A hypothesis can also be stated as a cause-and-effect ("If…then,…") statement. For example, "If there is more clay in the soil, then the rate of permeability will increase."
- The experiment is conducted to support or not support a hypothesis. If the hypothesis is not supported in the experiment, it can still be used to help rule out some other ideas.

It is not essential for students to generate questions based on prior investigations, develop a problem statement instead of a question for an investigation, or understand a null hypothesis.

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Assessment Guidelines:

The objective of this indicator is to *generate* questions that can be answered through scientific investigations; therefore, the primary focus of assessment should be to construct questions that can be tested and answered by conducting scientific investigations. However, appropriate assessments should also require students to *identify* the experimental variables in the question; *exemplify* questions that can be tested through scientific investigations; *exemplify* hypotheses appropriate to a given question; or *compare* the hypothesis to the question in an investigation.